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Factors Associated with Concurrent Tobacco Smoking and Heavy Drinking within a Women Firefighters' Sample

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Abstract: Studies showed that tobacco use and excessive alcohol consumption frequently occur, and both are significant causes of preventable morbidity and mortality. Data were collected as part of a national online study of the health of women in the fire service. Multinomial logistic regression was employed to determine factors associated with smoking and drinking characteristics. A total of 2330 women firefighters completed questions regarding tobacco and alcohol use; 3.2% (n = 75) were concurrent users, 0.9% (n = 22) were smokers only, 49.4% (n = 1150) were heavy drinkers only, and 46.5% (n = 1083) were low-risk users. Compared with those who neither smoked nor binge drank, concurrent users were more likely to be younger and live alone or not married. The findings also suggested that smokers, heavy drinkers, or those who were both were more likely to report symptoms of depression and PTSD and a history of physician diagnosis of anxiety disorder compared to low-risk users. Smoking rates are relatively low among women firefighters; however, mental health risks are prevalent, particularly for those who both smoked and drank heavily. Results can be potentially used to inform prevention and treatment research to better address the unique condition of this occupational group.

Keywords: alcohol; heavy drinking; tobacco use; smoking; concurrent use; women firefighters

Citation: Jitnarin, N.; Haddock, C.K.; Kaipust, C.M.; Poston, W.S.C.; Jahnke, S.A. Factors Associated with Concurrent Tobacco Smoking and Heavy Drinking within a Women Firefighters' Sample. *Fire* **2023**, *6*, 183. https://doi.org/10.3390/fire6050183

Academic Editor: Christine Eriksen

Received: 13 March 2023
Revised: 27 April 2023
Accepted: 28 April 2023
Published: 1 May 2023

1. Introduction

Tobacco and alcohol use are important modifiable risk factors for morbidity and mortality when used alone [1–3]. However, concurrent use exponentially increases the risk of various negative health outcomes, such as some types of cancer (e.g., mouth and throat, and liver cancer) [4] and heart and lung diseases [5]. It has been reported that in the United States (US), both tobacco and alcohol use accounted for 520,000 deaths or 21.6% of total deaths [6]. Almost half of alcohol-related deaths were linked to excessive alcohol use [7]. Despite the health risks and public harm associated with excessive alcohol consumption and smoking, the concurrent use of these two substances was commonly found within the US, with 27.5% and 16.4% of men and women using both alcohol and tobacco, respectively [8].

Firefighters are an essential occupational group target for public health efforts, given that they are a vital component of our nation's emergency and disaster response system and play a crucial role in protecting lives and property in the communities they serve. The nature of this profession makes firefighting a physically and mentally demanding occupation. Thus, health and readiness for duty have been a strong emphasis in the fire service. Smoking and problem drinking are among the most pressing health concerns identified by the US fire service due to their association with occupational functioning [9–11]. For instance, Punakallio and colleagues [9] reported that alcohol consumption and smoking were predictive of a decline in aerobic capacity among firefighters.

Furthermore, comorbidity puts individuals at higher risk for alcohol- and tobacco-related complications [1–3], and this risk may be even more pronounced among those in high-stress occupations such as firefighters. Numerous studies have examined tobacco and

alcohol use prevalence in the fire service though mostly among male firefighters [12–15], which is possibly due to their higher numbers in the fire service organization (92%) [16]. The published occupational epidemiology literature has also been largely focused on this occupational subgroup and typically excluded female firefighters from analysis. Unfortunately, several key health concerns of women firefighters have not been adequately studied or addressed.

A limited number of studies have examined tobacco and alcohol use prevalence among women firefighters [17,18], and none has reported the concurrent use of drinking and cigarette smoking in this group. Similar to male firefighters, health and readiness for duty among women firefighters is a critically important issue to the communities they protect. Alcohol and tobacco use adversely affect health status when used alone, but concurrent use exponentially increases the risk for poor health outcomes, especially in women. Recent research indicates that women have risks from cigarette smoking and excessive drinking that are unique or greater compared to men, such as cervical cancer, breast cancer, coronary health disease [19,20], and a negative impact on fetal development [20,21]. Despite the public health implications, the roles of women firefighters in providing emergency services and the need for them to be healthy and fit to carry out their duties, little is known about women firefighters' concurrent alcohol and tobacco use patterns or risk factors associated with the smoking and drinking behaviors in this group.

This study fills a gap in the literature on women firefighters and the concurrent use of tobacco and alcohol by presenting data from a Federal Emergency Management Agency (FEMA) sponsored national study of the health of women in the fire service. We also examine associations between smoking, heavy drinking, and co-use of both substances and key occupational risks among women firefighters. Identifying those factors associated with concurrent use, and use of one substance, has important implications for guiding the development of appropriate prevention and treatment programs.

2. Materials and Methods

The data reported are from the web-based prospective cohort study funded by FEMA (EMW-2015-FP-00848) from 2018 to 2020. The primary aim of this survey was to examine key health concerns in female firefighters, including maternal and child occupational health risks, behavioral health risks, cancer, and cardiovascular risk factors. The protocol for the protection of human subjects was approved by the NDRI-USA Institutional Review Board (IRB; approval number: 016-653).

2.1. Sampling Procedures/Firefighters Recruitment

Women firefighters can be described as an underrepresented population due to their extremely low representation in the US fire service (~8%) [16], and no national or central registry of firefighters currently exists. This study used several sampling strategies to solicit and recruit participants. Primary recruitment was pursued through different outlets including: (1) contacting participants from the research team's previous studies; (2) solicitating through Women in Fire membership, the only national organization representing women in the fire service; (3) soliciting through the International Association of Fire Fighters (IAFF); and (4) distributing email through the "Secret List", which is a popular email listserv in the fire service that is distributed to thousands of firefighters worldwide. Secondary recruitment included requesting any women completing the survey to share the solicitation with their female colleagues.

All women interested in participation were directed to a web-based survey. The initial page of the survey presented an informed consent document which described the scope and purpose of the study, provided contact information for the research team and the NDRI-USA IRB, and provided information about the survey's confidentiality and anonymity. Participants were informed about the voluntary nature of the survey as well as the risks and benefits they might expect from their participation in the study. After participants confirmed their consent to participate, they were then directed to the

series of questions contained in the survey. Once the dataset was completed, names and contact information were separated from the responses and stored on password-protected computers. The purpose of this study was to examine the experiences of women in the career fire service. This focus was chosen because the occupational health risks, interactions with colleagues and departments, and availability of training and gear can differ between career firefighters and volunteer firefighters. While volunteer firefighters may be exposed to similar risks depending on the circumstances of their firefighting duties, they may not have the same level of access to training and protective gear as career firefighters. The National Fire Protection Association (NFPA) [22] defines a career firefighter as a firefighter who is employed full-time by a fire department and receives compensation for providing fire suppression or other related services, regardless of whether they engage in structural firefighting or other types of firefighting. Therefore, for the purpose of this study, the term career firefighter is based on the NFPA definition and includes only firefighters in municipal fire departments that protect people, residences, and public buildings. It does not include wildland or volunteer firefighters. By focusing on women in the career fire service, this study aimed to shed light on the unique challenges and experiences of this underrepresented group within the firefighting profession. Of the 3108 women who consented to participate, 2988 had completed data on their tobacco and alcohol use (96.1% completion rate), and 2330 (77.9%) were career firefighters.

2.2. Measures

Standard individual demographics (e.g., age, race/ethnicity, educational level, marital status) and occupational history (e.g., current rank, years serving in fire service) were collected along with the following:

2.2.1. Cigarette Smoking Measures

Three cigarette smoking questions were used to determine smoking status: (a) Have you ever smoked a cigarette or even a puff? (b) Have you smoked at least 100 cigarettes in your entire life? and (c) Have you smoked a cigarette, even a puff, in the past 30 days? [23] Participants who answered "no" to question (a) were defined as never smokers. Those who answered "yes" to question (a) but "no" to question (b) were defined as experimental smokers. Those who answered "yes" to questions (a) and (b) but "no" to question (c) were designated as former smokers, while participants who answered "yes" to all three questions were classified as current smokers.

2.2.2. Alcohol Use Measures

Alcohol use was assessed with the item: "During the past 30 days, have you had at least one drink of any alcoholic beverage such as beer, wine, a malt beverage, or liquor?" Level of alcohol consumption was assessed with the item "During the past 30 days, on the days when you drank, about how many drinks did you drink on the average?". Consuming two or more drinks per day on average in the past 30 days was categorized as heavy drinking [24]. Potential alcohol abuse was assessed with the 4-item CAGE questionnaire [25]. Each affirmative response contributes one point to an overall score range of 0 to 4. A total score of two or greater indicates a potential alcohol problem.

2.2.3. Physical Health

The self-rated health question was used to measure participants' overall health. Participants were asked to rate their current health on a 5-point Likert scale where 1 = excellent, 2 = very good, 3 = good, 4 = fair, and 5 = poor. This question has established reliability and validity [26] and is predictive of various health outcome variables, including healthcare utilization [27] and mortality [28]. The Self-Report of Physical Activity (SRPA) questionnaire was used to measure physical activity patterns during the past 30 days [29], ranging from 0 (avoids walking or exertion) to 7 (engages in heavy physical activity >3 h/week). Fitness was measured using estimated maximal oxygen uptake (VO_2 max) relative to body

weight using a non-exercise model [29] and then dichotomized into meeting NFPA fitness guidelines of 12 metabolic equivalents (METs). Firefighters also were asked whether they had experienced an occupational injury in the past 12 months [30,31].

2.2.4. Mental Health

The 10-item Center for Epidemiological Studies Short Depression Scale (CESD-10) was used to assess current depressive symptoms [32]. The sum scores range from 0 to 10, with a total score of 4 or more indicating possible depression. The 6-item RAND Mental Health Inventory anxiety subscale (MHI-A) was administered to assess participants' anxiety [33] during the past month. Each item is scored on a six-point Likert scale ranging from 1 (all the time) to 6 (none of the time). Following the developer's instructions [34], all scores were standardized by recoding the items into a linear transformation ranging from 0 to 100–lower scores indicating having higher anxious states [33,35].

Symptoms of trauma experienced were assessed with the 10-item Trauma Screening Questionnaire (TSQ). A score of six or higher positive responses indicates being at risk for PTSD [36]. Participants were also asked to report whether they had ever been diagnosed with an anxiety or depressive disorder. History of anxiety was assessed with: "Has a doctor or other healthcare provider EVER told you that you had an anxiety disorder (including acute stress disorder, anxiety, generalized anxiety disorder, obsessive–compulsive disorder, panic disorder, phobia, posttraumatic stress disorder, or social anxiety disorder)?" History of depressive disorder was determined with: "Has a doctor or other healthcare provider EVER told you that you have a depressive disorder (including depression, major depression, dysthymia, or minor depression)?"

2.2.5. Occupational-Related Factors

The chronic work discrimination and harassment abbreviation (CWDH-A) scale was used to measure the occurrence and frequency of perceived chronic interpersonal discrimination that participants experience at work. They were asked to rate how often they have experienced six at-work situations over the past year using a 5-point scale ranging from 1 (once a week or more) to 5 (never)–lower scores indicating greater experiences with workplace discrimination and harassment [37].

Job satisfaction and organizational commitment were assessed based on the following items from previous studies [38,39]. Response options were a five-point Likert scale ranging from 1 (very much disagree) to 5 (very much agree) and scored in a continuous fashion, with high scores indicating a greater level of job satisfaction.

2.3. Statistical Approach

In order to explore potential differences between different tobacco and alcohol use, participants were categorized into one of the four groups based on self-reported smoking and drinking. Models were developed examining demographic, health, and job-related characteristics differences based on previous studies [12,14,18]. Concurrent users were defined as participants who were reported as current smokers and met the criteria of heavy drinking were classified as concurrent users while participants who currently reported not smoking (i.e., being non-smokers, former- and experimental smokers) and did not meet the criteria for heavy drinking were classified as low-risk users. Low-level drinkers (who reported no more than one drink per day) were included with non-drinkers because their low consumption does not highly associate with negative alcohol-related consequences [40,41]. Participants who reported being current smokers but did not meet the criteria for heavy drinking were classified as smokers only, whereas those who met the criteria for heavy drinking but reported being a non-smoker were classified as heavy drinkers only.

All statistical models examining correlates of different categories of smoking and alcohol use were performed using R Statistical Software (v4.2.1; R Core Team 2022). Bivariate analyses were used to identify characteristics that differed among the smoking and binge drinking groups to include in the regression model and reported percentages

(discrete variables) and means or adjusted least squared means (continuous variables) for variables in each domain. A multinomial logistic regression model was used to compare each of the three smoking and heavy drinking categories (smokers, heavy drinkers, concurrent users) to the low-risk user group (i.e., not smoking and did not meet the criteria for heavy drinking) and adjusted for any firefighter demographic or occupational factors that were significantly different between the four groups. All variables of interest were included in regression modeling, and the stepAIC function in the R package MASS (v7.3-58.1; Ripley et al. 2022) was used to create a parsimonious model. The odd ratios, 95% CI, and p-value ($p < 0.05$) were used to evaluate results for significance, and model fit was explored. Age-standardized overall prevalence rates of alcohol consumption and cigarette smoking were computed using standard tables from the US Census to facilitate comparison with national and military estimates [42].

3. Results

3.1. Characteristics of Participants

Overall, the majority of the sample was non-Hispanic White (87.2%), had completed at least some college education (97.4%), and held a firefighter position (72.6%). Almost half of the participants (49.4%) reported heavy drinking in the past month, while only 0.9% (n = 22) reported being a smoker. Concurrent users of cigarettes and alcohol made up only 3% of the sample (n = 75) (Table 1). There were no significant differences among smoking/binge drinking groups on most demographic characteristics. However, there were group differences in age and marital status. With regards to age, heavy drinking firefighters (38.2 ± 8.9 years) were significantly younger than smokers (46.6 ± 8.7 years). In addition, low-risk users were significantly more likely to be married or living with a partner than their smoking or heavy drinking group counterparts. Regarding occupational characteristics, women firefighters who smoked cigarettes were significantly older than other smoking/drinking groups and less likely to be in the firefighter ranks. No differences in job discrimination and job satisfaction among smoking/heavy drinking status were found (Table 1).

Table 1. Characteristics of female career firefighters stratified by smoking and alcohol groups (N = 2988; M ± SD; Least Square Means ± SE *; %) †.

Variables	Smoking/Drinking Group			
	Low-Risk Users (n = 1083)	**Smoker Only (n = 22)**	**Heavy Drinker Only (n = 1150)**	**Concurrent User (n = 75)**
Demographics				
Age (years)	39.5 ± 9.2 ^{a}	46.6 ± 8.7	39.1 ± 9.6 ^{a}	38.2 ± 8.9 ^{a}
Race (% White, non-Hispanic)	88.2	86.4	86.3	86.7
Education (% some college or higher)	97.6	100.0	97.4	94.6
Marital status (% married or living with partner)	68.0 ^{a}	52.4 ^{abc}	50.7 ^{b}	30.7 ^{c}
Years in the fire service (years)	13.2 ± 8.1 ^{a}	18.6 ± 8.1	13.3 ± 8.6 ^{a}	11.5 ± 8.3 ^{a}
Rank (% firefighter)	74.9	59.1	70.2	81.3
Health				
BMI (kg/m^2)	25.6 ± 0.1 ^{a}	27.8 ± 0.9 ^{ab}	26.2 ± 0.1 ^{b}	26.3 ± 0.5 ^{ab}
Physical activity level	4.9 ± 0.1 ^{ab}	3.3 ± 0.4 ^{c}	5.0 ± 0.1 ^{a}	4.5 ± 0.2 ^{bc}
Meet NFPA fitness standard	43.0 ^{a}	5.0	36.3 ^{b}	36.0 ^{ab}
Self-report general health	2.1 ± 0.0 ^{a}	2.7 ± 0.2 ^{b}	2.0 ± 0.0 ^{a}	2.3 ± 0.1 ^{b}
Injury (% ≥ 1 injury)	29.6 ^{a}	50.0 ^{ab}	38.0 ^{b}	36.5 ^{ab}

Table 1. *Cont.*

Variables	Smoking/Drinking Group			
	Low-Risk Users (n = 1083)	**Smoker Only (n = 22)**	**Heavy Drinker Only (n = 1150)**	**Concurrent User (n = 75)**
Psychosocial				
Potential alcohol problem	5.6 ^{a}	0.0 ^{abc}	21.2 ^{b}	34.7 ^{c}
Possible depressive symptom	20.5 ^{a}	40.0 ^{abc}	28.0 ^{b}	48.6 ^{c}
Anxiety score	26.6 ± 0.6 ^{a}	24.9 ± 3.9 ^{abc}	24.2 ± 0.5 ^{b}	32.8 ± 2.1 ^{c}
Depressive disorder diagnosis	20.4 ^{a}	22.7 ^{ab}	23.8 ^{a}	37.3 ^{b}
Anxiety disorder diagnosis	17.7 ^{a}	50.0 ^{b}	21.0 ^{a}	34.7 ^{b}
Being at risk for PTSD	17.6 ^{a}	36.4 ^{ab}	23.0 ^{b}	33.3 ^{b}
Job discrimination	3.2 ± 0.0	3.2 ± 0.2	3.2 ± 0.0	3.1 ± 0.1
Job satisfaction	4.1 ± 0.0 ^{ab}	4.1 ± 0.2 ^{ab}	4.1 ± 0.0 ^{a}	3.8 ± 0.1 ^{b}

* Health and psychosocial variables comparisons among groups were adjusted for age and marital status and reported as Least Square Means ± SE. † Different superscript letter denotes differences among smoking and alcohol use categories at $p < 0.05$.

3.2. Factors Associated with Concurrent Use, Smoking Only, Heavy Drinking Only Compared to Low-Risk Users

The results of the multinomial regression which compared each smoking and drinking group (smoker only, heavy drinker, and concurrent user) to low-risk users (reference group) are described below and in Table 2. After adjusting for demographic differences, smokers were more likely to rate their own health as fairer or poorer (OR = 3.76, 95% CI = 1.41–9.99) compared to the low-risk users. In addition, participants in the heavy drinking group were more likely to report an alcohol use problem (OR = 4.56, 95% CI = 2.96–7.02) compared to those who were defined as low-risk users. Firefighters who smoked and were heavy drinkers were more likely to rate their own health as fairer or poorer (OR = 1.86, 95% CI = 1.28–2.71) and were almost ten times more likely to have an alcohol use problem (OR = 9.56, 95% CI = 4.88–18.72) than the low-risk users. The findings also showed that other factors associated with being smokers, heavy drinkers, or both compared to being a low-risk user were a likelihood of being at risk for PTSD and having an anxiety issue. Women firefighters who reported smoking were found to have a higher likelihood of exhibiting signs of PTSD risk (OR = 8.03, 95% CI = 1.62–39.91) in comparison to their smoking/drinking counterparts.

Table 2. Multinomial Logistic Regression Models of Association between Demographic, Health, and Psychosocial Characteristics among Cigarette Smoking and Alcohol Use Status †.

Characteristics	Smoker Only vs. Low-Risk User	Binge Drinker Only vs. Low-Risk User	Concurrent User vs. Low-Risk User
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**
Demographic			
Years of service	1.02 (0.95–1.11)	0.99 (0.97–1.00)	**0.95 (0.92–0.99)** **
Marital Status			
Not living with a partner	Ref	Ref	Ref
Married or living with a partner	0.30 (0.07–1.32)	**0.59 (0.46–0.75)** ***	**0.28 (0.15–0.50)** ***
Health			
Self-report general health	**3.76 (1.41–9.99)** **	1.09 (0.93–1.29)	**1.86 (1.28–2.71)** **
Psychosocial			
Alcohol Problem			

Table 2. *Cont.*

Characteristics	Smoker Only vs. Low-Risk User	Binge Drinker Only vs. Low-Risk User	Concurrent User vs. Low-Risk User
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**
Not having alcohol problem	Ref	Ref	Ref
Potential alcohol problem	**0.004 (0.004–0.004) *****	**4.56 (2.96–7.02) *****	**9.56 (4.88–18.72) *****
Anxious state	**0.93 (0.87–0.99) ***	1.00 (0.99–1.01)	1.01 (0.99–1.03)
PTSD			
Not being at risk for PTSD	Ref	Ref	Ref
Being at risk for PTSD	**8.03 (1.62–39.91) ***	0.87 (0.64–1.19)	0.95 (0.48–1.88)

† Multinomial logistic regression model with low-risk users as the reference group. The bold values indicate significant differences between the cigarette smoking/alcohol use categories. OR = odds ratio and CI = Confidence Interval. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

4. Discussion

To our knowledge, this is the first study to investigate factors associated with smoking, heavy drinking, and the concurrent use of cigarettes and alcohol use compared to low-risk users among women firefighters. The demographic correlates of substance use (i.e., cigarette and/or alcohol) identified in the current study were consistent with those found in general population studies. Cigarette and alcohol use participants were significantly more likely to be younger and living alone/without a partner than their low-risk colleagues. These are consistent with previous research indicating that cigarette and/or alcohol use individuals were predominantly young, unmarried adults [40,43]. They also are consistent with findings that being married or living with a partner is protective against cigarette and alcohol consumption [44,45]. For example, Salvatore and colleagues [45] found that married individuals used less alcohol and tobacco than single or divorced/separated individuals. Prescott and Kendler [46] also noted that the frequency and quantity of alcohol consumption among married women were lower than among single individuals.

Firefighters who were smokers and/or heavy drinkers reported low self-rated health and less engagement in physical activity, with smokers reporting the lowest self-rated health conditions and being the least physically active. Self-reported general health has been used as an index of health-related quality of life and demonstrated predictive validity with health care utilization and mortality [27,28]. It has been consistently reported that weight status and physical activity are associated with lower self-rated health, so it is not surprising that substance use participants rated their health as poor/fair, given their high BMI and low physical fitness [47,48]. The associations between low self-rated health and cigarette/alcohol use reported by firefighters in this study were similar to those found in the military [49].

Women firefighters who engaged in heavy drinking and who were both smokers and heavy drinkers were at higher risk for alcohol use problems compared to their non-binge drinker counterparts based on the CAGE screening questionnaire [25]. It has been hypothesized that a number of stressors unique to this occupational group play a critical role in elevating substance use behaviors [17,38]. Other research with the U.S. women samples also supports the strong association between stress and alcohol and cigarette use [50,51]. For example, Witkiewitz et al. [51] found that increased stress was associated with high concurrent drinking and smoking rates. Thus, it may be that women firefighters use alcohol and cigarettes to cope with occupational stress and trauma. Problem drinking and smoking were significantly associated with common mental health issues in the fire service, such as anxiety, depression, and PTSD symptoms [12,17,18]. It is not surprising that women firefighters in our study who reported smoking were more likely to report having mental health issues such as a history of physician-diagnosed depression or anxiety, or PTSD symptoms.

There were significant group differences in current depressive symptoms, as measured by the CESD-10 among smoking and drinking status. The CESD-10-determined rate of current depression in our sample was double (25.2%) that found among the US female adult population for any depression (10.4%) [52] and higher than the rate of female active duty military personnel (e.g., 16.2%) [53]. Findings are consistent with previous research that indicated increased rates of depressive symptoms among firefighters compared to the general population [39,54–56]. It has been proposed that these negative symptoms are related to the psychological stress associated with a job that exposes individuals regularly to traumatic events.

Of note, overall age-standardized cigarette smoking prevalence for our sample of female career firefighters (3.3%) is substantially lower when compared to the rates for US adult women (11.0–13.6%) [57,58] and remains far lower than the US state that had the lowest smoking prevalence in the country (West Virginia, 22.5%) [58]. This rate also was lower than that of male firefighters (13.2%) [14]. The difference in smoking prevalence between women firefighters and women military personnel was very pronounced. Female military personnel smoked cigarettes at more than six times the rate in our women sample (12.8% vs. 2.0%) [59]. In contrast, alcohol consumption was common among women firefighters, with more than three-quarters (79.1%) of participants reporting drinking alcohol in the past month, of which 49.4% met the criteria for heavy drinking. Age-adjusted prevalence for heavy drinking in our study cohort was two times higher than the rates for US adult women (48.6% vs. 22.2%) [60] and eight times higher than that reported in DoD (5.9%) [59] but comparable to the rates among male firefighters (44.8–52.5%) [12,13,61]. The overall crude and age-standardized prevalence of the concurrent use of both substances (i.e., smokers and heavy drinkers) were 3.2% and 2.5%, respectively, which were relatively lower than estimates found within the women population in the US (16.4%) [8] and their male firefighter counterpart (19.0%) [12].

Limitations of the current study include the sampling method and the potential for response bias, the cross-sectional design, and the fact that cigarette smoking and alcohol drinking and health outcomes were based on self-report. However, the approach used in this study represented the most reasonable strategy and feasible method to reach a large number of women firefighters who were described as an underrepresented population (i.e., extremely low representation, no central or national lists exist of women firefighters). Given the sample size and the assumed number of women firefighters nationally (~8%) [16] of the nation's 350,000 career firefighters, this sample likely represents between 8 and 10% of the nation's female firefighters, which is a large proportion of the total estimated number of career women firefighters in the U.S. We limited this study to career women firefighters who smoke cigarettes and drink alcohol, sample characteristics and results may not be generalizable to volunteer women firefighters or nationally representative. Another limitation is the relatively small sample size for certain subgroups, such as smokers only and concurrent users of tobacco and alcohol. For example, the smoker group consisted of only 22 participants, which may limit the generalizability of the findings to a larger population of women who smoke. In addition, the small sample size may not be sufficient to detect meaningful differences in the health outcomes compares to low-risk users. Nonetheless, this study can help to understand the correlates of co-use tobacco and alcohol and for intervention targeting.

In addition, this study's cross-sectional design prevented us from determining the direction of relationships between substance use and health outcomes longitudinally. Future work should explore prospective relationships between tobacco and alcohol use and the effect on health outcomes. Although the data on cigarette smoking and alcohol use relied on self-report, there is strong evidence regarding the reliability and validity of using self-report tobacco and alcohol use in population-based surveys [62,63] and among firefighters [14,17,18]. Besides, the study survey utilized valid and reliable instruments measuring health and psychosocial outcomes. Therefore, estimates of the

prevalence of substance use and its related health outcomes are unlikely to have been biased by self-reporting.

5. Conclusions

This study suggests the need for additional research and an increased focus on the use of tobacco, specifically cigarettes, and alcohol in women firefighters. Although the numbers of those who were a smoker and heavy drinkers were relatively low compared to those who were heavy drinkers only, intervention is still required to determine the best practice in this occupational group. Future studies also should examine the rates of concurrent use of cigarette and alcohol and changes in both smoking and heavy drinking trajectories across time and determine the prospective relationships between risks of co-use and subsequent health problems. The study offers data that can inform interventions and treatment related to cigarette smoking and alcohol consumption among this population. Interventions and policies for smoking cessation should incorporate alcohol drinking cessation and the impact of this substance use on health and psychosocial behaviors to achieve higher health benefits.

Author Contributions: Conceptualization, N.J.; Methodology, S.A.J., C.K.H., W.S.C.P. and N.J.; Validation, N.J. and C.M.K.; Formal Analysis, N.J.; Data Curation, N.J., C.M.K. and C.K.H.; Writing—Original Draft Preparation, N.J.; Writing—Review & Editing, N.J., C.K.H., C.M.K., S.A.J. and W.S.C.P.; Supervision, S.A.J., C.K.H. and W.S.C.P.; Funding Acquisition, S.A.J. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the Assistance to Firefighters Grants program managed by the Federal Emergency Management Agency in the Department of Homeland Security (EMW-2015-FP-00848). The opinions, findings, and conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect those of the funding agency or the U.S. Fire Service.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of NDRI-USA, Inc. (protocol/reference number: 016-653; date of approval: 12 September 2016).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data cannot be shared publicly because participants' consent was not given for the information collected to be shared.

Acknowledgments: The authors would like to thank all of the women firefighters for participating in this study with the goal of improving firefighter health and readiness.

Conflicts of Interest: The authors declare no conflict of interest.

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